INSTRUCTION MANUAL

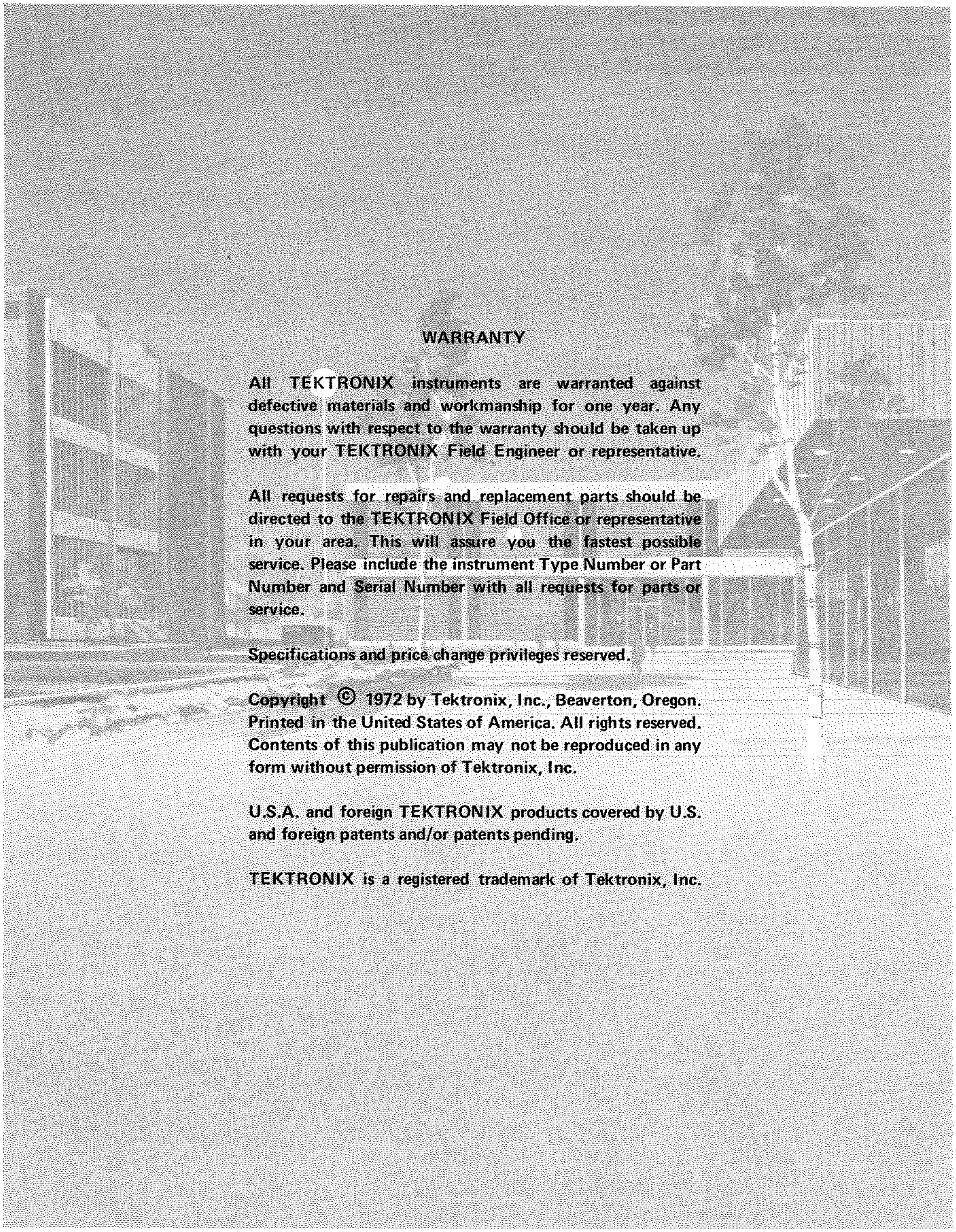
Serial Number ____________

5A14N FOUR CHANNEL AMPLIFIER

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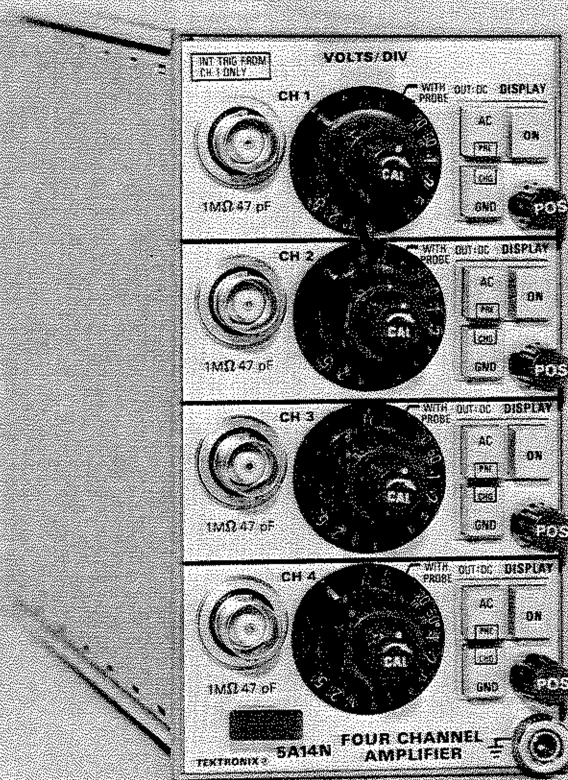


WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

Specifications and price change privileges reserved.



INT TRIG FROM CH 1 ONLY
VOLTS/DIV
CH 1
WITH PROBE
OUT: DC
DISPLAY
AC
GND
ON
CAL
POS
1MΩ 47 pF
CH 2
CH 3
CH 4
TEKTRONIX®
5A14N
FOUR CHANNEL AMPLIFIER

SECTION 1
OPERATING INSTRUCTIONS

Instrument Description

The 5A14N Four Channel Amplifier is a general-purpose plug-in unit for use with Tektronix 5100-series oscilloscopes. The unit contains independent amplifier channels with identical characteristics, and features solid-state circuitry and simplicity of operation. The VOLTS/DIV knob skirts are lighted to provide a direct readout of calibrated deflection factor either with or without a probe. Any channel may be used to produce a single-channel display. All channels may be displayed alternately, or channel 4 and 3 may be alternated with 2 and 1 to produce four displayed channels. While designed primarily for use as a vertical amplifier, the unit can be operated in conjunction with the horizontal deflection system of the oscilloscope for X-Y displays.

CONTROLS AND CONNECTORS

This is a brief description of the function or operation of the controls and connectors. Additional operating information is given under General Information.

DISPLAY	Applies logic levels to the oscilloscope system to enable plug-in operation. The switch functions only when the plug-in is operated in one of the vertical plug-in compartments.
POSITION	Positions display.
VOLTS/DIV	Volts per major graticule division. Selects calibrated deflection factors from 1 mV/Div to 5 V/Div; 12 steps in a 1-2-5 sequence. Knob skirt is illuminated to indicate deflection factor. Readout is automatically scaled when readout-coded 10X probe is installed.
Variable (CAL) Volts/Div	Provides uncalibrated, continuously variable deflection factors between calibrated steps; extends range to 12.5 V/Div.
Input Coupling Pushbuttons	AC-DC: Button pushed in selects capacitive coupling of input signal; button out selects direct coupling of input signal. GND: Disconnects the input signal and provides ground reference to the amplifier input stage. PRE CHG: Both AC and GND buttons pushed in allows precharging of the coupling capacitor. Release GND for measurement.
Single or Dual Beam Selector (Internal)	Slide switch at the rear of the plug-in that selects the channel logic sequence. When the switch is in the forward position (toward the front panel), the plug-in is in the single-beam mode, which provides a 4-3, 4-3, 2-1, 2-1 logic sequence. In the opposite position, the plug-in is in the dual-beam mode, which provides a 4-3-2-1 logic sequence.
Input Connectors	BNC connectors for application of external voltage signals. Includes a coded-probe input ring for activation of X10 readout.

BASIC OPERATION

Preparation

The 5A14N is calibrated and ready for use when received. It can be installed in any compartment of the 5100-series oscilloscope, but it is intended for use primarily in vertical compartments (the center and left compartments). For X-Y operation, the 5A14N may also be installed in the horizontal (right) compartment (refer to the 5100N Oscillscope System Instruction Manual for information on X-Y operation).

NOTE

If the oscilloscope system receives no DISPLAY ON logic levels from the vertical plug-ins, it is designed to display the unit in the left compartment.

To install, align the upper and lower rails of the 5A14N with the plug-in compartment tracks and fully insert it (the plug-in panel must be flush with the oscilloscope panel). To remove, pull the release latch to disengage the 5A14N from the oscilloscope.

The first few steps of the following procedure are intended to quickly obtain a trace on the screen and prepare the instrument for immediate use. The remainder of the steps demonstrate some of the basic functions of the 5A14N. Operation of other instruments in the system is described in the instruction manuals for those units.

1. Insert the unit all the way into the oscilloscope system plug-in compartment.

2. Turn the oscilloscope Intensity control fully counterclockwise and turn the oscilloscope power on. Preset the time-base and triggering controls for a 2-millisecond/division sweep rate and automatic triggering.

3. Set the 5A14N front-panel controls as follows:

CH 1 through CH 4

DISPLAY	ON (deflection factor illuminated)
POSITION	Midrange
VOLTS/DIV	.2 V (Calibrated)
Input Coupling	DC, GND

4. Adjust the Intensity control for normal viewing of the four traces.

5. Position the traces two divisions apart with the POSITION controls.

6. Apply a 400-millivolt peak-to-peak signal (available at the oscilloscope Calibrator loop) through a test lead or 1X probe to the CH 1 input connector.

7. Release the CH 1 GND pushbutton. The display should be square waves approximately two divisions in amplitude, with the bottom of the display at the reference established in step 5. Adjust Trigger Level, if necessary, to obtain a stable display. Rotate the CAL control throughout its range, observing a reduction of the display amplitude. Return the CAL control to the detent (calibrated Volts/Div) position.

NOTE

The preceding procedure applies for each channel. However, the internal trigger signal for the time-base plug-in is obtained from CH 1 only.

8. To demonstrate AC-coupled operation, position (with the POSITION control) the bottom of the display to the graticule centerline.

9. Push in the AC button and note that the display shifts downward to its average level.

Step Attenuator Balance (Each Channel)

If the internal control is not properly adjusted, the CRT zero reference point (trace or spot) will shift vertically due to differential DC imbalance in the amplifier as the VOLTS/DIV switch is rotated throughout its range. The shift is more noticeable on the most sensitive positions.

a. With the instrument operating, ground the input (GND button pushed in) and set the VOLTS/DIV switch to 5 V. Move the trace to the graticule center with the POSITION control.

b. Rotate the VOLTS/DIV switch throughout its range and adjust the appropriate internal Step Atten Bal control for minimum trace shift.

Gain Check (All Channels)

The vertical and horizontal deflection systems of the 5100-series oscilloscopes are gain-standardized to permit a plug-in to be moved from one oscilloscope to another (or from one compartment to another within the oscilloscope) without the need to recheck the calibration each time. However, the 5A14N gain can be checked and, if necessary, adjusted.

This completes the basic operating procedure for the 5A14N. Instrument operations not explained here or those that need further explanation are discussed under General Information.

GENERAL INFORMATION

Applying Signals

When measuring DC voltage, use the largest deflection factor (5 V/Div) when first connecting the 5A14N to an unknown voltage source. If the deflection is too small to make the measurement, switch to a lower deflection factor.

In general, probes offer the most convenient method of connecting a signal to the input of the 5A14N. Tektronix probes are shielded to prevent pickup of electrostatic interference. A 10X attenuator probe offers a high input impedance and allows the circuit under test to perform very

close to normal operating conditions. The 5A14N is designed for compatibility with coded probes, such as the Tektronix P6060 and P6052 Passive Probes. The input connector has an outer ring to which the coding ring on the probe connector makes contact. This type of probe allows the vertical deflection factor indicated by the readout to correspond with the actual deflection factor at the probe tip, eliminating the need to consider the attenuation factor of the probe when measuring the signal amplitude on the graticule scale. See your Tektronix, Inc., catalog for characteristics and compatibility of probes for use with this system.

Sometimes unshielded test leads can be used to connect the 5A14N to a signal source, particularly when a high-level, low-frequency signal is monitored at a low-impedance point. However, when any of these factors is missing, it becomes increasingly important to use shielded signal cables. In all cases, the signal transporting leads should be kept as short as practical. Be sure to establish a common ground connection between the device under test and the 5A14N. The shield of a coaxial cable or ground strap of a signal probe provides an adequate common ground connection.

Channel Sequence Logic

The 5A14N has two channel-sequence modes selected by the internal Single Beam/Dual Beam selector. In the forward or Single Beam position (toward the front panel), the channels are displayed in a 4-3, 4-3, 2-1, 2-1 sequence. In the rear or Dual Beam position, the channels are displayed in a 4-3-2-1, 4-3-2-1 sequence. The Single Beam sequence is necessary in order to display all channels when operating with a single-beam 5100-Series Oscilloscope where each vertical compartment is given two time slots in sequence before the other compartment receives its two time slots. Since a possible four channels per compartment may be desired, a double count of each 4-3 and 2-1 pair is necessary. The Dual Beam sequence is useful when only one vertical compartment of a single-beam oscilloscope is being used, or when a dual-beam oscilloscope is being used in any YT mode.

Input Coupling

The AC-DC pushbutton switch allows a choice of input coupling. The type of display desired will determine the coupling used.

DC coupling (button out) can be used for most applications. However, if the DC component of the signal is much larger than the AC component, AC coupling (button in) will probably provide a better display. DC coupling should be used to display AC signals below about 2 hertz as they will be attenuated in the AC position.

In the AC position, the DC component is blocked by a capacitor in the input circuit. The low-frequency response in the AC position is about 2 hertz (−3 dB point). Therefore, some low-frequency attenuation can be expected near this frequency limit. Distortion will also appear in square waves which have low-frequency components.

The GND pushbutton provides a ground reference at the amplifier input. The signal applied to the input connector is presented with a one-megohm load, while the amplifier input is grounded. This eliminates the need to externally ground the input to establish a DC ground reference.

Pre-charging. To minimize surge currents in the circuit under test when using deflection factors of 50 mV/Div through 1 mV/Div and a test lead or 1X probe, use the AC-DC and GND pushbuttons to take advantage of the pre-charging circuit incorporated in the unit. The pre-charging circuit permits charging the coupling capacitor to the DC source voltage when the AC and GND buttons are pressed in, and also limits surge current to the coupling capacitor from the signal source. The procedure for using this circuit is as follows:

a. Before connecting the 5A14N to a signal containing a DC component, push in the AC and GND buttons. Then connect the input to the circuit under test.

b. Wait about one second for the coupling capacitor to charge.

c. Remove the ground from the coupling capacitor (GND button out). The display will remain on-screen and the AC component can be measured in the usual manner.

Deflection Factor

The amount of trace deflection produced by a signal is determined by the signal amplitude, the attenuation factor (if any) of the probe, the setting of the VOLTS/DIV switch, and the setting of the Variable control. The deflection factors indicated by the VOLTS/DIV switch are calibrated only when the CAL control is rotated fully clockwise into the detent position.

The range of the CAL control is at least 2.5:1. It provides uncalibrated deflection factors covering the full range between the fixed settings of the VOLTS/DIV switch. The control can be set to extend the deflection factor to at least 12.5 volts/division.

Display Modes

SINGLE TRACE. To display a single channel, apply the signal to the desired input and press the DISPLAY button to display the corresponding channel.

FOUR TRACE. To display all four channels, press all the DISPLAY buttons.

Trigger Source

The internal trigger signal for the time-base plug-in unit is obtained from the Channel 1 display only. Select the trigger source by pushing the CH 1 DISPLAY button.

Oscilloscope Applications

Refer to the Operating Instructions of the 5100 Oscilloscope System manual for basic oscilloscope applications, including peak-to-peak AC voltage measurements, instantaneous DC voltage measurements, comparison measurements, time-duration measurements, determining frequency, risetime measurements, X-Y measurements, etc.

ELECTRICAL CHARACTERISTICS

Performance Conditions

The following characteristics apply when the 5A14N is operating within the environment described in the 5100-series Oscilloscope System manual. In addition, the 5A14N must have been calibrated at an ambient temperature between +20°C and +30°C.

Display Modes

Selectable by switch on rear panel. All four channels displayed alternately, i.e., 4-3-2-1-4-3-2-1, or channel 4 and 3 alternated with 2 and 1, i.e., 4-3-4-3-2-1-2-1, which provides a full display of left and right vertical channels when the 5A14N is used in a 3 plug-in single-beam system.

Bandwidth (−3 dB)

DC (DIRECT) COUPLED: DC to at least 1 MHz.

AC (CAPACITIVE) COUPLED: 2 Hz or less to at least 1 MHz.

Deflection Factor

1 mV/Div to 5 V/div within 2% in a 12 step, 1-2-5 sequence.

Uncalibrated, continuously variable between steps and to 12.5 V/div.

Maximum Safe Input Voltage

DC (DIRECT) COUPLED: 350 V (DC + peak AC).

AC (CAPACITIVE) COUPLED: 350 VDC.

Channel Isolation

0.1 division with an 8 division signal source or 50 db, whichever is greater.

Input RC

1 MΩ paralleled by ≈47 pF.

SECTION 2

THEORY OF OPERATION

Introduction

This section contains an electrical description of the circuits in the 5A14N Four Channel Amplifier unit. A complete block and schematic diagram is given on a pullout page at the back of the manual.

The four channels are nearly identical except for Trigger Pickoff, which occurs in Channel 1 only. Thus, this discussion concerns only Channel 1 except for the Channel Switching portion, which necessarily involves all the channels.

Plug-in Logic

When the DISPLAY button, S510, is pressed, a logic level is applied to the electronic switching circuit in the oscilloscope to enable plug-in operation (this button has no effect when the plug-in is inserted in a horizontal plug-in compartment). Power is applied to illuminate the front-panel knob-skirt readout lamps, indicating the ON mode.

Input Coupling

Signals applied to the front-panel input connectors may be capacitive coupled (AC), direct coupled (DC), or internally disconnected (GND). Provision is made to pre-charge (or discharge) the input capacitor to protect delicate circuitry under test. When both the AC and GND buttons are pressed, the input to the amplifier is grounded and the input capacitor is pre-charged through a one-megohm resistor to the level of the applied input signal.

Input Attenuator

The deflection factor of the plug-in is set by a combination of gain switching in the amplifier and input attenuation.

The input attenuator is a frequency-compensated voltage divider that provides 100X attenuation in the 0.1 V to 5 V positions of the VOLTS/DIV switch. At DC and for low-frequency signals, the divider is essentially resistive (attenuation ratio determined by the resistance ratio of R107 and R108). At higher frequencies, the capacitive reactance becomes effective and the attenuation ratio is determined by the impedance ratio.

In addition to providing constant 100X attenuation, the input attenuator maintains a constant input RC characteristic (one megohm paralleled by about 47 pF) for 0.1 V to 5 V settings of the VOLTS/DIV switch.

Amplifier

The input amplifier consists of two identifical feedback amplifiers, connected in a paraphase configuration. Quiescently, the two sides of the amplifier are balanced by the internal Step Atten Bal adjustment R115 so there is no current through the gain-setting resistor (R123 through R128). See Fig. 2-1. An input signal is developed across the

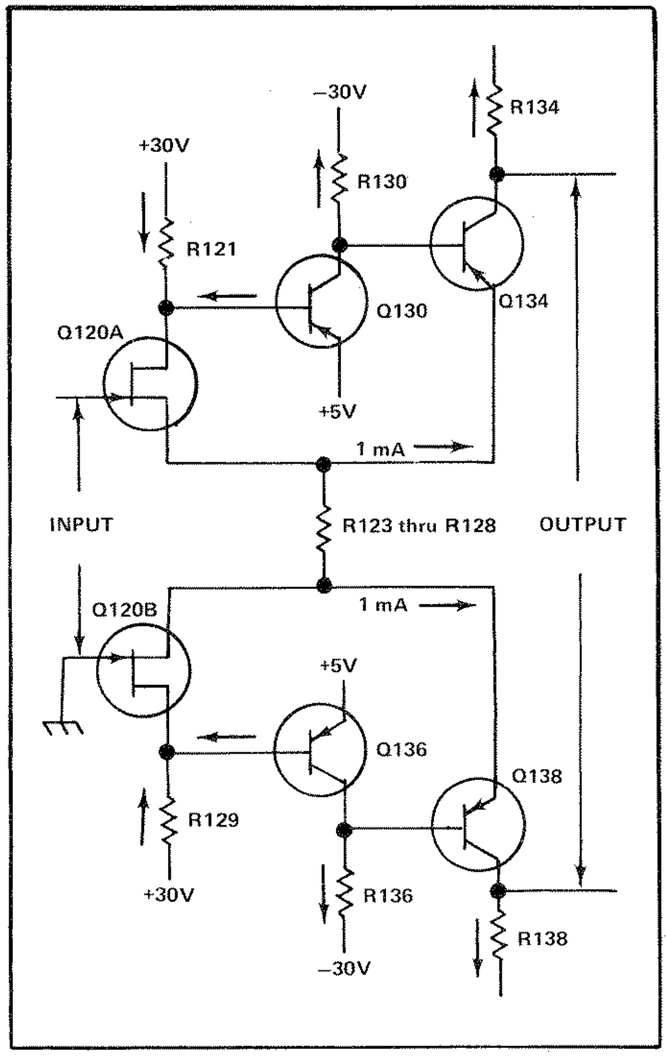


Fig. 2-1. Input amplifier partial diagram showing quiescent current paths.

gain-setting resistor, shifting the current through Q134 and Q138 by the amount established through R123-R128, and developing a push-pull output signal across R134 and R138. The gain of this amplifier ranges from about one to fifty, and is primarily determined by the ratio of the gain-setting resistor to the sum of R134 and R138.

The push-pull signal voltage from Q134 and Q138 collectors then passes through emitter followers Q142 and Q146 and is transformed to a signal current by Q160 and Q162.

The Variable VOLTS/DIV (CAL) potentiometer R168, and the Gain-setting potentiometer R166, reduce the gain in the Q160-Q162 stage by developing an adjustable amount of signal voltage between their emitters.

Q150, Q156 and Q158 in Channel 1 only receive the push-pull signal and provide a single-ended trigger signal out. Q177 and Q178 provide positioning current.

Channel Switching

When only the CH 1 DISPLAY button S510 is pressed, Q510 is biased off, turning on Channel 1 switches Q180 and Q182 and allowing a signal to pass.

When only the CH 2 DISPLAY button S520 is pressed, Q510 is biased on, switching Q516 off. This action turns Channel 2 switches Q280 and Q282 on.

When both CH 1 and CH 2 buttons are pressed (dual-trace mode), the state of Q510 and Q516 is determined by the channel-switching signal generated in the oscilloscope mainframe. The form of this signal is selected on the sweep plug-in by the Alternate-Chop Mode button.

Channels 3 and 4 operate as a switched pair just as Channels 1 and 2. Thus, the Channel 3 switches Q380 and Q382 are controlled by Q520, and the Channel 4 switches Q480 and Q482 are controlled by Q526. When both Channels 3 and 4 are ON, they are either alternated or chopped as a pair through Q520 and Q526 by the channel-switching signal.

Channels 1 and 2 are displayed as a composite pair when their composite switches Q530 and Q534 are turned on. This occurs when Q550 is biased off. Channels 3 and 4 composite switches Q540 and Q544 are similarly turned on when Q556 is biased off. When one or two channels from each composite pair are ON, U550 switches between the two pairs at either 1/2 or 1/4 the Alternate or Chop rate of the channel-switching signal. U550 divides the channel-switching signal by 2 in the Dual Beam position or by 4 in the Single Beam position of S550. The divided channel-switching signal from S550 determines the state of Q550 and Q556 when 1 or 2 channels from each composite pair are ON.

Probe Sensing

Either of two lamps located behind the VOLTS/DIV knob skirt illuminates the selected deflection factor to provide a direct readout. Normally, DS190 is lit; connection of a readout-coded 10X probe extinguishes DS190 and lights DS196. This changes the knob skirt readout by a factor of 10 to reflect the probe attenuation, eliminating possible operator error.